

rain in falling washes the air from a large proportion of the suspended organic matters inseparable from a crowded city, and also from the unburnt particles of carbon, which incomplete combustion allows to escape from our chimneys; and charged with these, it still collects more dirt of various kinds from the roofs of our houses, and finally finds its way into our water-butts as the semi-putrid sludge which often causes the true-bred cockney to wonder "if this so-called purest form of natural water is so foul, what on earth must the other forms of water be like?" If in the country the rain water is collected and stored in suitable reservoirs, then we have the most perfect water that can be obtained for washing and cleansing purposes.

In some kinds of water collected under what we might consider ideal circumstances, we find "a something" which acts as a check upon the cleansing action of the soap.

In Attica, close to Athens, on the slopes of Mount Pentelicus, the Emperor Hadrian built some huge marble underground aqueducts to collect and lead the rain water down as a supply for Athens, the whole water-shed consisting of marble; this mountain being justly celebrated as the source from which the finest statuary marble is obtained. Here, falling through the clear southern air on to a collecting ground formed of the material which all ages have considered the most suitable for baths and reservoirs, one would expect the water to be like the pure rain water, absolutely free from dissolved solid impurities, and one of the best waters of its kind for washing purposes; yet not only does it waste a large amount of soap before a lather is obtained, but if we examine the channels through which it has for centuries flowed down to the valley, we find that it has formed a heavy deposit, which collecting unchecked through long ages, has all but choked up the once spacious passages. A piece of this deposit I have obtained through the kindness of a friend, and on analysis it proves to be:—

|                  |     |     |     |        |
|------------------|-----|-----|-----|--------|
| Calcic carbonate | ... | ... | ... | 96.81  |
| Silica...        | ... | ... | ... | 0.49   |
| Organic matter   | ... | ... | ... | 1.40   |
| Moisture         | ... | ... | ... | 1.30   |
|                  |     |     |     | 100.00 |

It is, in fact, a natural incrustation deposited by the water, and a similar action is seen in the formation of stalactites in many caverns, through the roof of which water charged with certain calcareous compounds has slowly found its way.

In the passage of the rain through the air small quantities of carbon dioxide or carbonic acid gas are dissolved from the atmosphere, whilst in slowly percolating through the surface soil on which it has fallen the water is brought in contact in the pores of the soil with far larger volumes of this gas, which is being continually generated there by the decomposing vegetation and other organic matter in a state of decay. Under these circumstances the water becomes highly charged with the gas, and sinks on through the ground until it comes in contact with some impermeable strata through which it cannot penetrate, and here it collects until a sufficient head of water has been formed for it to force its way along the strata to the surface of the earth, where it now appears as a spring, and during this passage through the earth it has dissolved everything that will yield to its own solvent action or to the activity of the carbon dioxide, which dissolved in water forms the weak carbonic acid, a compound which will dissolve many substances insoluble in the water itself, such as calcic carbonate, occurring in the soil as marble, limestone, or chalk, and also the carbonates of iron and magnesium. If we examine a spring water, we shall find that its dissolved impurities can be divided into two classes: for instance, taking the Kent water supplied at Greenwich, and obtained from deep wells in the chalk, we find its saline constituents in grains per gallon are:—

|                      |     |     |     |       |
|----------------------|-----|-----|-----|-------|
| Calcic carbonate     | ... | ... | ... | 16.30 |
| Calcic sulphate      | ... | ... | ... | 5.37  |
| Magnesian sulphate   | ... | ... | ... | 0.93  |
| Magnesian nitrate    | ... | ... | ... | 1.20  |
| Sodic chloride       | ... | ... | ... | 2.64  |
| Sodic nitrate        | ... | ... | ... | 1.21  |
| Silica, alumina, &c. | ... | ... | ... | 0.97  |

And of these the calcic sulphate, magnesium, and sodium salts are dissolved by the solvent action of the water in the same way that sugar would be, whilst the chief impurity, calcic

carbonate, is scarcely at all soluble in the water itself, 16,000 parts of pure water only dissolving one part of the carbonate, but is readily soluble in the carbonic acid, in the water which converts it into soluble calcic bicarbonate.

In the household, waters are roughly classified as hard or soft waters, and the property of hardness manifests itself, as a rule, to the householder by its action upon soap, and also by the amount of "fur" which it causes in the kettle, these actions being due to calcic bicarbonate, calcic sulphate, and the magnesium salts present in it, all of which act upon soap and cause it to curd instead of forming a lather by converting the soluble sodic oleate and stearate into insoluble lime salts, whilst the bicarbonate by decomposing and depositing "chalk" causes the fur.

A more careful examination, however, reveals the fact that this property of hardness owes its origin to two different causes, for if we boil water until all the bicarbonate is broken up and the calcic carbonate deposited, the clear water left behind it is still hard, though to a far less extent, and will still decompose a certain proportion of soap. The hardness which can be got rid of by boiling is due to bicarbonate of lime, and sometimes also bicarbonate of magnesia, and is called "temporary hardness," whilst the hardness left after boiling the water is due to calcic sulphate and the soluble magnesium sulphate, chloride and nitrate, and is called "permanent hardness."

The relative hardness of waters is estimated by the amount of soap they will destroy, *i.e.* convert from the form of soluble sodic oleate and stearate into the condition of insoluble oleates and stearates of lime, and one grain of calcic carbonate or its equivalent in sulphate or salts of magnesia dissolved in a gallon of water, is said to equal 1° of hardness.

The sample of Kent water of which an analysis has been given, contains 23.6 grains of these salts, and would be said to have nearly 24° hardness, 7.5° of which would be permanent and 16.3° temporary.

When it is considered that 1° of hardness in water will waste 10 grains of soap per gallon of water used, we become aware of the economic importance of the kind of water employed in the household, a gallon of the Kent water, for instance, using up 236 grains or nearly half an ounce of soap before any becomes available to form a lather and exert a cleansing action upon the skin.

Glasgow used to have a hard water service, and when this was discontinued and the soft Loch Katrine water was supplied in its place, it made a difference of several thousands a year in the money expended in soap.

From these facts it is manifest that a soft water supply is an important factor in cheapening our cleansing processes, a pure rain water being the best attainable, whilst surface and river water are as a rule softer than spring water.

I have now discussed the chemistry of cleaning as fully as the time at my disposal will permit, and I hope the facts I have brought before you will have quickened your interest in soap, soda, and water, and will have helped to impress upon you that without proper processes of cleansing, the health of each unit, and therefore the prosperity of the masses, must suffer deterioration.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following pass list for the degree of Doctor of Science of London University has been issued:—Experimental Physics: Mr. Edwin Henry Barton. Chemistry: Mr. Bevan Lean, Mr. Thomas Kirke Rose, Mr. Arthur Landauer Stern. Botany: Miss Margaret Jane Benson. Zoology: Mr. Arthur Willey.

HER MAJESTY'S Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1894, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country:—Scholar nominated by the University of Edinburgh, John Carruthers Beattie; by the Univer-

sity of Glasgow, James Robert Erskine-Murray; by the University of Aberdeen, William Brown Davidson; by University College, Bristol, Reginald Charles Clinker; by Yorkshire College, Leeds, Frankland Dent; by University College, Liverpool, Alfred James Ewart; by University College, London, David King Morris; by Owens College, Manchester, Julius Frith; by Durham College of Science, Newcastle-on-Tyne, Robert Beattie; by University College, Nottingham, William Beckett Burnie; by Queen's College, Galway, John Alexander McClelland; by the University of Toronto, Frank Boteler Kenrick; by Dalhousie University, Halifax, Nova Scotia, Frederick James Alexander M'Kittrick.

THE President and Council of the Royal Society have, upon the recommendation of the Joule Studentship Committee, elected Mr. J. D. Chorlton, of the Owens College, to the first Joule Studentship. This studentship was founded for the purpose of enabling students to carry on certain researches on lines laid down by Dr. Joule, more especially with the view of determining the constants of some of the instruments employed by him, which his representatives can place at the student's disposal.

## SOCIETIES AND ACADEMIES.

### LONDON.

Royal Society, May 31.—“The Root of *Lyginodendron Oldhamium*, Will.” By Dr. W. C. Williamson, F.R.S., and Dr. D. H. Scott.

During a re-investigation of the structure of *Lyginodendron*,<sup>1</sup> the results of which the authors hope to lay before the Royal Society on a future occasion, an important fact has come to light, which they place on record without delay.

A carboniferous fossil, with the structure perfectly preserved, has been described in previous memoirs, under the name of *Kaloxylon Hookeri*, Will.<sup>2</sup> The authors have now established the fact that *Kaloxylon* was not an independent plant, but was the root of *Lyginodendron Oldhamium*.

Specimens, presenting in every respect the typical *Kaloxylon* structure, have been found in actual continuity with the stem of *Lyginodendron*, arising from it as lateral appendages. Their structure and mode of origin prove that they were adventitious roots. These organs branched freely, and the authors have found roots and rootlets of all sizes, and at all stages of development.

This discovery enables a complete account to be given of the vegetative organs of *Lyginodendron*, as they are now fully acquainted with the structure, not only of the stem and foliage, but also of the adventitious roots.

June 14.—“On a Method for determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold, and Platinum.” By James H. Gray.

The object of this investigation was to obtain a method for determining thermal conductivities of metals, which would not require either elaborate preparations or large quantities of the substances to be tested, and by means of which a test could be made in a few hours.

The essence of the method is to keep one end of a given length of the wire at a constant known temperature, and to measure the rise of temperature of the other end of the wire every minute. If proper precautions be taken to prevent loss by radiation from the sides, the data are obtained for calculating the thermal conductivity.

The wire to be tested is soldered at one end into the bottom of a copper box. The diameters found most convenient were from 2 to 4 mm., the lengths from 4 to 8 cm.

The box is filled with water and supported at its middle by being fitted into an asbestos-lined wooden screen, 24 × 24 cm. 3 mm. length of the other end of the wire is soldered into a solid copper ball, diameter 5·5 cm. In the ball a hole 3 cm. deep is made, so as to admit the bulb and part of the stem of a small and very sensitive thermometer. This thermometer is graduated from 5° C. to 20° C., and can easily be read to within one-fortieth of one degree. The bulb is surrounded by water.

<sup>1</sup> Cf. Williamson, “On the Organisation of the Fossil Plants of the Coal Measures,” Part IV. *Phil. Trans.* 1873, p. 377; Part XVII. *Phil. Trans.* 1890, B. p. 89.

<sup>2</sup> Cf. “On the Organisation of the Fossil Plants of the Coal Measures,” Part VII. *Phil. Trans.* 1876, Part 1, p. 1; Part XIII. *Phil. Trans.* 1837, B. p. 289.

All the probable errors are practically tested by using different lengths or diameters of the wire, and the results obtained in the present investigation indicate that the errors have been eliminated.

In order to make a complete test of a metal it is only necessary to take a wire of 5 or 6 cm. length and solder it firmly, the one end into the bottom of the heating box, the other into the calorimeter ball. The water in the heating box is kept boiling briskly, and readings are taken every half-minute from the thermometer in the ball. These readings are then put upon a curve as ordinates, with the time in minutes as abscissæ. From this curve the rise of temperature per unit time can then be accurately read off, and, the thermal capacity of the ball being already determined, the flow of heat per unit time is obtained.

At the beginning of the experiment the ball is cooled to about 6° or 7° C. below the temperature of the air, and the rise for equal temperatures above and below that of the air taken, the radiation being thus eliminated.

The metal which was chiefly used for the exhaustive tests of the method was copper wire, of diameter 0·21 cm., density 8·85, volume specific (electrical) resistance at about 13° C. 1834 in absolute units.

It must be noted that the found values are the means of the conductivities corresponding to the temperatures at the ends of the wire. When compared with the values obtained by other experimenters, the results of the latter must be taken for the mean of 97° C. and 10° C., that is, 53° C.

For this temperature Ångström gives 0·9208.

Several qualities of copper were tested, as well as pure gold, silver, and platinum, kindly lent for investigation by Messrs. Johnson, Matthey, and Co.

The values are given below:—

Mean Conductivity between Temperatures 10° C. and 97° C.

|                     |     | Thermal conductivity in C.G.S. units. | Diameter. |
|---------------------|-----|---------------------------------------|-----------|
| Copper, Specimen 1  | ... | 0·9594                                | 2·00 mm.  |
| “ “ 2               | ... | 0·88838                               | 2·11 “    |
| “ “ 3               | ... | 0·8612                                | 3·09 “    |
| “ “ 4 (very impure) | ... | 0·3497                                | 2·04 “    |
| “ “ 5               | ... | 0·3198                                | 2·04 “    |
| Silver (pure)       | ... | 0·9628                                | 2·02 “    |
| Gold                | ... | 0·7464                                | 2·00 “    |
| Platinum            | ... | 0·1861                                | 2·00 “    |

“Flame Spectra at High Temperatures. Part III. The Spectroscopic Phenomena and Thermo-Chemistry of the Bessemer Process.” By Prof. W. N. Hartley, F.R.S.

The flame issuing from the mouth of a Bessemer converter was first investigated by Sir Henry Roscoe<sup>1</sup> in 1863; by Lielegg,<sup>2</sup> and by Marshall Watts in 1867;<sup>3</sup> by Tunner,<sup>4</sup> J. M. Silliman, Rowan,<sup>5</sup> Von Lichtenfels,<sup>6</sup> Spear Parker,<sup>7</sup> Kupelwieser,<sup>8</sup> Brunner,<sup>9</sup> and Wedding in 1868;<sup>10</sup> also by A. Greiner in 1874.<sup>11</sup>

Up to the present time the precise nature of the spectrum, the cause of its production, its sudden disappearance when decarburisation of the metal takes place, and the connection between the decarburisation of the metal and the extinction of the spectrum have not been satisfactorily explained. According to Roscoe, Lielegg, Kupelwieser, and Spear Parker, the spectrum is characterised by bands of carbon or of carbon monoxide, which disappear when all carbon is burnt out of the metal.

On the other hand, the investigations of Simmler,<sup>12</sup> Brunner, Von Lichtenfels, and Wedding, the spectrum is not due to

<sup>1</sup> Literary and Phil. Soc., Manchester, *Proc.*, vol. 3, p. 57, and *Phil. Mag.*, vol. 34, p. 437.

<sup>2</sup> *Sitzungsberichte Kaiserl. Akademie der Wissenschaften*, Wien, vol. 56, Part ii.

<sup>3</sup> *Phil. Mag.*, vol. 34, p. 437.

<sup>4</sup> *Dingler's Polytech. J.*, vol. 178, p. 465.

<sup>5</sup> *Phil. Mag.*, vol. 41, p. 1.

<sup>6</sup> *Dingler's Polytech. J.*, vol. 191, p. 213.

<sup>7</sup> *Chem. News*, vol. 23, p. 25.

<sup>8</sup> *Oesterreichische Zeitschr. für Berg- und Hütten-Wesen*, No. 8, p. 59.

<sup>9</sup> *Loc. cit.*, No. 29, p. 227, 1863.

<sup>10</sup> *Zeitschrift für das Berg Hütten- und Salinen-Wesen*, vol. 27, p. 117.

<sup>11</sup> 1869.

<sup>12</sup> *Revue Universelle*, vol. 35, p. 623.

<sup>13</sup> *Zeitschr. für Analytische Chemie*, 1862.